DOCUMENT RESUME

ED 154 569 EC 110 316

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TITLE Science Education for the Deaf: Comparison of Ideal Resource and Mainstream Settings.
PUB DATE Mar 78
NOTE 23p.; Paper presented at the American Education Research Association Annual Meeting (Toronto, Ontario, Canada, March, 1978)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Art Activities; Aurally Handicapped; *Deaf; Elementary Education; Exceptional Child Research; *Mainstreaming; Peer Relationship; Program Effectiveness; *Resource Room Programs; Science Education; *Science Instruction; Student Attitudes

ABSTRACT

Ideal mainstreaming conditions were compared to ideal resource conditons for science and art instruction of 21 deaf students (10-13 years old). Results of nonverbal interviews, teacher observation and opinion surveys of nonhandicapped children indicated that gains in science knowledge were not significantly different for the resource and mainstreamed students; response of normal peers to the science and art programs was generally favorable, with younger students more uneasy about the presence of handicapped children than their older peers; and deaf students engaged in interactive learning experiences in either situation. (CL)

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Science Education for the Deaf:

Comparison of Ideal Resource and Mainstream Settings

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Paper presented at American Education Research Association Meeting, Toronto, Ontario, Canada, March, 1978.

Printed in U.S.A.

EC110316

Abstract

Educators, legislators, lawyers, and spokesmen for the handicapped have endorsed the program to mainstream handicapped children (PL 94-142). The present study was undertaken to determine some of the potential advantages from such a program. In this study, ideal mainstreaming conditions were compared to ideal resource conditions. Deaf children were taught science and art in either a resource or mainstreamed setting. Evaluation of the impact of the program included examination of cognitive gains, observation of behavior under the two conditions, and assessment of the reaction of non-handicapped children to the introduction of handicapped students into their classes.

Science Education for the Deaf: Comparison of Ideal Resource and Mainstream Settings

Public Law 94-142 mandates "mainstreaming" of handicapped children by placing them in regular classes and educating them with non-handicapped children to the maximum extent possible. The rationale for this decision is that more equitable educational experiences for handicapped children will result. Some educators have pointed out that handicapped children may have special needs which cannot be met in mainstreamed classes. The critical competitor to the mainstreamed class is the resource classroom where the handicapped child has a specially trained teacher and is a member of a small group (three to six students). At the moment, the advantages of mainstreamed vs. resource classes are not well understood (e.g., Bitter & Johnson, 1973).

The purpose of this research, supported by the W. T. Grant Foundation of New York, was to compare resource and mainstreamed settings for deaf children. The questions were: (1) Will children learn more in a resource setting where they can receive individual attention? (2) How will regular students react to handicapped peers? (3) What will deaf students do differently in mainstreamed as opposed to resource classes.

The educational program used for the resource and mainstream program was developed by Doris Hadary at American University. It consisted of instruction in both science and art. The science materials included adaptations from the Science Curriculum Improvement Study, Science: A Process Approach, The Elementary Science Study, and the curriculum development group at the Lawrence Hall of Science, Berkeley, California. The art program was designed by the staff at American University to supplement

and augment the ideas presented in the science program. The three questions were investigated using (1) pretest and posttest interviews covering the cognitive aspects of the science instruction, (2) questionnaires administered to non-handicapped children to assess their reaction to having handicapped children in their classes, and (3) classroom observations of the deaf children in each educational setting.

Educational Program

The mainstreamed classes took place at Mann Elementary School near American University. The resource classes took place in a specially designed classroom at American University. Each class consisted of a 45-minute science lesson and a 45-minute art lesson. The order of science and art was counterbalanced each week so each student had science first one week and art first the next week. All classes took place right after lunch from September until May (22 weeks).

The science program was a hands-on, interactive experience. The program has been described by Walsh (1977) in Science. In particular, Walsh notes, "In the Mann classroom there is a feeling of harmony and camraderie..." (p. 1425). The actual content of the science program in each of the classrooms reflected the level of the students in the class. The art program was designed to augment and reinforce the instruction in the science program.

Mainstreamed Classes

All four 1st through 4th-grade classes at Mann School were involved in the mainstreamed program one day a week. Each regular class was split in half, so about 15 regular students were in each mainstreamed class. In addition, two deaf, two blind, and one emotionally disturbed student were

added to each half of the class.

The deaf and blind children were transported by bus to Mann School for the mainstreamed program. The emotionally disturbed students were identified by the school but not served by any program. It should be pointed out that busing children in for one class is not typical of mainstreaming. In the typical mainstreamed situation the handicapped children would be present for the entire day. However, this design seems justified since (1) very little information is available concerning the effect of mainstreaming on handicapped and non-handicapped children, (2) random assignment of handicapped children was possible, and (3) direct control of the curriculum content was possible. Clearly, these conditions could not be met in a mainstreamed school.

The teachers of the resource and mainstreamed classes were Robert Haushalter and Richard Rosenberg. These teachers have four years of training with handicapped children. The teachers divided their time equally between the resource and mainstreamed classes. In addition, two preservice teacher aides and an observer were present for every class.

Resource Classes

Three deaf students, a teacher, an aide, and an observer were present in each resource class. The same materials were used in the resource class and the mainstreamed class on a given day.

Procedure

Subjects and Design

Deaf subjects consisted of 21 students attending the Grant School, an

inner-city, mixed SES, predominantly black school for the deaf. These subjects were assigned at random to either the mainstreamed situation or the resource room. Seven subjects came on each of the three days. Groups were assigned by age and the youngest deaf students were placed with the youngest regular students. Each day four subjects were assigned to the mainstreamed situation, two to each half of the regular classroom, and three subjects participated in the resource program. The same subjects remained in the same program throughout the entire year. Deaf subjects ranged in age from 10 years 9 months to 13 years 9 months. The deaf children were somewhat older than the mainstreamed students which they worked with. All the deaf students were legally deaf. Their hearing losses were predominantly total, severe, and congenital, although one student had a partial hearing loss ameliorated with a hearing aide.

Mainstream subjects attended Mann School, a racially mixed school. The 1st-grade, 2nd-grade, and the 2nd-3rd combination were taught with the Grant School deaf students. A 3rd-4th-grade combination class was taught with students from the Montgomery County deaf program. Only the reaction of the 3rd-4th-grade combination students to having handicapped children in their classroom was evaluated.

Evaluation of Cognitive Gains: Interview

Since this was an innovative program no appropriate evaluation instruments were available. A nonverbal interview was developed to assess the performance of deaf children in science. A sample item from the interview is shown in Figure 1.

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Insert Figure 1 about here

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Using the same mode as the program used for instruction, the interview was based on hands-on experiences. Subjects were presented with materials and allowed to manipulate them. The interviewer modeled the appropriate pattern for responding and used several demonstration questions, then the test questions were introduced. For the question shown in Figure 1, the Water Level Task, the subject was shown a glass bottle filled with blue water and was asked to match the level of the water in the bottle with some cards showing the water and the bottle in various configurations. Then the bottle was covered with an opaque shield and rotated. The subject was asked to indicate how the water would now look in the bottle. The interview consisted of the Water Level Task (Task I) and four other tasks presented in a similar format. Task II assessed the concepts of shape, thickness, material, and color. Tasks III and IV assessed the concepts of living, nonliving, system, observation, and exploration. Task V assessed the concepts of observation and exploration, dissolving, interaction, and system. The interviews were administered in a 25-minute session by a trained interviewer. The interviewer was not trained in sign language and did not attempt to use speech to communicate task directions.

Observation Instrument

To assess whether the experience of the handicapped child is different in the resource and mainstreamed classes, an observation instrument was developed. Observers were asked to categorize the behavior of the student that they were observing at 5-second intervals, using the eight categories described in Table 1. Observers were preservice teachers trained to use

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Insert Table 1 about here

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the instrument. Students were observed for 5 minutes in a different order at each observation session. These observations were then tallied and the percentage of time that each of eight categories was observed was computed.

Opinion Survey

The reaction of the non-handicapped children to mainstreaming was assessed by a questionnaire. The questions are shown in Tables 2 and 3. In addition, students wrote what they liked most and least about the program.

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Insert Tables 2 & 3 here

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The 1st-grade children did not receive the questionnaire because they could not easily read it.

Results and Discussion

The program of science and art instruction was very well received. Throughout the year, students were enthusiastic and eager when it came time for science or art.

Results of Cognitive Tests

The interviews were administered to the same deaf students before the program and after it was completed. Results were analyzed using the Wilcoxon Matched Pairs Signed Ranks Test. As can be seen in Table 4, both resource program students and mainstreamed students made significant

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Insert Table 4 about here

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gains on two parts of the interview. On the Water Level Task students in the resource program made significant gains from pretest to posttest. Students in the mainstreamed program made significant gains on drawing the water level only. Differences between the resource program and the mainstreamed program are not significant. The relevance of both the science and the art program to the observed gain is likely. It should be noted that all of the boys gained on this question, while 7 of the 11 girls gained.

Both the resource and mainstreamed group made overall significant gains on knowledge of the concepts of material, shape, color, and thickness. Closer examination of the results indicated that these gains reflected increased awareness of the concepts of material and color. The concept of shape was well understood by subjects on the pretest, and no progress was made in understanding the concept of thickness.

Assessment of performance on the other three parts of the interview revealed no gains for either group. Both the preliminary nature of the interview and the fact that some of the concepts evaluated were not taught during the available time contributed to this finding.

Certainly, one concern with the advent of mainstreaming has been that the handicapped child would receive less attention and perhaps less opportunity to learn. The results of the cognitive tests do not support this. Gains were similar although in the resource program the ratio of students to teachers was much lower than in the mainstreamed situation.

Observation Results

The eight categories used to code the behavior of the deaf children in the resource and the mainstreamed situations are shown in Table 1. It was

found that categories 2, 6, 7, and 8 each were coded less than 5% of the time. This finding substantiates the aim of the program. First, the program was designed so that students would not spend time reading or writing about science, and less than 5% of the time were handicapped students observed to be either reading or writing about science. Category 6 (getting or returning equipment) was also recorded less than 5% of the time, indicating that efficient procedures for passing out and collecting equipment were used by the teachers. As anticipated, category 7 (boredom) and category 8 (disruptions) occurred infrequently.

The percentage of time coded for categories 1, 3, 4, and 5 is shown in Table 5. As can be seen, category 1 (working with apparatus) was the

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Insert Table 5 about here

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most frequently coded category comprising 60% of the students' time on the average. Categories 3, 4, and 5 were coded approximately equally often; each comprised 0-10% of the students' time on most observations.

To test the hypothesis that resource students engage in different activities than mainstreamed students, the Kolmogorov-Smirnov Two Sample Test was used. Significant differences were found for categories 1 and 3. The resource group spent less time engaged in category 1 (working with apparatus) than the mainstreamed group ($X^2 = 6.14$) and more time describing or discussing science than the mainstreamed group ($X^2 = 31.1$). In the mainstreamed situation there is a larger group of students, and a handicapped child would be more likely to spend time manipulating materials rather than discussing his results. On the other hand, in the resource situation where one teacher is present for three students, the likelihood for dis-

cussion of results is enhanced. These two forms of behavior are both interactive and both provide feedback for the students.

The finding of no differences in coding for categories 4 and 5 attests to the similarity of teaching at the two sites. It is reassuring to discover that students in the mainstreamed as opposed to the resource situation spent no more time listening to lectures or observing demonstrations and that these two behaviors were infrequent.

Questionnaire Results

To assess opinions about the program and about having handicapped children in class, 2nd through 4th-graders in the mainstreamed program answered a questionnaire during the final week of instruction. Recall that the 3rd-4th-grade class had deaf students from Montgomery County who were already mainstreamed but did not have science.

As can be seen in Table 2, response to the science and art programs was generally favorable. Approximately one-half of the students involved in the mainstreamed program would like to have the science and art classes every day and have them last for two hours. Consistently, the 2nd-grade class and the 3rd-4th combination class were more positive towards art than towards science, whereas the 2nd-3rd combination class was more positive towards science. The 3rd-4th class was the least positive; only 27% reported science as being always fun, and they rated both science and art as less fun, less interesting, more confusing, and less informative than did their younger counterparts. The overwhelming preference in this 3rd-4th group for art as opposed to science (73% preferred art) might reflect the other classroom experiences of these students.

As shown in Table 4, the reaction of mainstreamed students to handicapped children was uneven. The older children were more interested and excited about the presence of handicapped children than were the younger students (e.g., 28% reported some fear of the handicapped students in the 2nd-grade class and only 10% reported fear in the 3rd-4th-grade class). These changes with age may indicate a better understanding of the socially accepted response by older children.

As anticipated, close to 50% of the students in each class indicated that having handicapped students in science and art did take extra time. This was not a major problem since the students also reported a great deal of satisfaction from the science and art classes. Nevertheless, this factor deserves consideration in the design of mainstreamed classrooms.

Besides the questions shown in Tables 2 and 3, each mainstreamed student was asked to write what they liked best and least about mainstreaming. Over one-half of the 2nd-graders and over two-thirds of the older students indicated that the best thing about having deaf and blind kids in science was that they were fun and interesting. Over two-thirds of the students in both groups indicated no problems with mainstreaming. Those who indicated problems noted (1) that handicapped students got special attention or took too long to understand the science or art lesson, (2 that handicapped students were hard to understand or were silly or grabby, or (3) that they could not easily communicate with handicapped students or felt sorry for them. Credit to these young students' perceptiveness is that 25% of them mentioned that they were learning about other people from this experience. Ten of the mainstreamed students mentioned examples of how handicapped students could help them to better understand something in science or art.

Summary and Conclusions

In this paper, a comparison of an ideal resource program and an ideal mainstreamed situation for deaf students is reported. Three forms of evidence suggest the advantages of the mainstreamed situation. (1) Results of cognitive tests show no difference in gains between resource students and mainstreamed students. (2) Observations indicate that deaf students engage in interactive learning experiences in either situation, although in the resource setting there are more opportunities for discussion and reporting of results verbally, whereas in the mainstreamed situation there are more opportunities for working with apparatus. (3) Non-handicapped students, in general, were very favorable about the presence of handicapped children in their classes and, in fact, frequently pointed out the advantages of having the handicapped children. The youngest students were more uneasy about the presence of handicapped children than their older peers.

Non-handicapped mainstreamed students indicated that having deaf students in their classes did take more time and pointed out that deaf students frequently requested additional attention. As anticipated, mainstreaming places additional demands on the teaching staff. Clearly, aides will be needed in mainstreamed classes to deal with this problem. Even the experienced teachers used in this trial needed two aides to run the program. In addition, this program did not involve reading and writing which would probably require more teacher intervention. Since the observation results revealed that deaf children had more opportunities for discussion in the resource than in the mainstreamed setting, it appears that communication skill might be enhanced more in a resource than in a mainstreamed situation. Further research is needed in this area.

It has been argued that mainstreaming might enhance the self-image of the handicapped child. In this program, the handicapped students (1) made cognitive gains in the classroom with non-handicapped children, and (2) were well accepted by their mainstream peers (e.g., an observer wrote that a deaf child helped one of the non-handicapped students and reported that it made him feel important). Such experiences are likely to enhance self-image as well as increase mutual understanding between handicapped and non-handicapped students.

The success of mainstreaming will undoubtedly depend on the training of teachers. The master teachers in this program had received excellent training. Clearly, generalization of the results of this study must be tempered with this information.

References

Bitter, G. B., & Johnson, K. Review of literature: Integration of exceptional children into regular school classes (Office of Education Grant #0-72-0251). University of Utah, Project Head, 1973.

Walsh, E. Lab classroom: Breaking the communication barrier. Science, 196, 1425, 1977.

Table 1

Categories Used in Observation of Handicapped Students

1. Working with apparatus. Student is building, interacting with, or changing apparatus (e.g., sorting shells, building tower, etc.).

2. Science content. Student is reading or writing something about science (e.g., filling our student sheet).

3. Describing or discussing science. Student is discussing his experiment or describing his results with peers or leader (e.g., talking to partner, telling leader his results, participating in class discussion).

4. Listening to description of science. Student is listening to a teacher or student describe science (e.g., teacher lecture).

5. Observing science. Student is observing a teacher demonstration or another student's experiment (e.g., walking around watching peers do experiments, watching a movie, watching teacher show how apparatus works).

6. Getting or returning equipment. Student is waiting for equipment to be passed out or collected. Student is doing some unclear science related activity (e.g., waiting for pencil, holding up hand to get leader's attention).

7. Bored, distracted, engaged in non-science activity. Student is not doing science (e.g., reading non-science book, writing a letter, playing with paper).

8. Disruptive. Student is creating a problem which disturbs other students or requires the leader to control the situation.

Table 2

Responses to Questions to Assess Preference for Science or Art Among Non-Handicapped Students (Percentages)

Question	2nd grade		2nd/3rd grade		3rd/4th grade	
	Science	Art	Science	Art	Science	Art
I would like to have class every day	31	52	63	47	40	70
I would like to have a two hour class	31	54	53	43	43	70
Class was always fun	64	73	70	60	27	57
Class was always interesting	60	54	73	43	33	50
Class was never confusing	56	50	53	70	33	77
Class always taught me a lot	68	56	60	37	40	33
Class never needed more teachers	76	56	67	57	83	87
Class never needed more equipment	44	32	47	43	33	53
Would choose science over art	54		57		27	

Table 3

Responses to Questions to Assess Preference of Non-Handicapped Students for Handicapped Students in Their Class (Percentages)

	2nd grade	2nd/3rd grade	3rd/4th grade
Prefer handicapped in science and art	45	73	87
Would choose a handicapped partner in			
science	21	73	48
art	24	70	41
Having handicapped kids in class			
was never scary	72	83	90
was always fun	36	43	63
was always interesting	24	73	57
was never confusing	44	67	90
never took extra time	52	40	50

Table 4

Histograms of Two Cognitive Questions

Administered to Handicapped Students

I. Water Level Task

Resource Program N = 9	Mainstreamed Program N = 12
1 = boy 2 = girl 2 2 2 2 2 1 1 1 1 0 1 2 3 4 5 Pretest scores	 2 2 2 2 2 1 2 2 1 1 2 1 0 1 2 3 4 5 Pretest scores
2 2 2 2 1 2 1 1 1 0 1 2 3 4 5 Posttest scores	2 2 2 2 2 1 2 1 1 1 2 2 0 1 2 3 4 5 Posttest scores
Pretest-posttest dif. significant Wilcoxon $p < .05$	Pretest-posttest dif. significant Wilcoxon $p < .05$

Table 4 (continued)

II. Material-Shape-Color-Thickness Task

Resource Program N = 9	Mainstreamed Program N = 12
2 2 1 2 1 2 1 1 2 0 1 2 3 4 Pretest scores	2 2 2 1 2 1 2 1 2 2 1 2 0 1 2 3 4 Pretest scores
2 2 1 1 2 1 2 1 2 0 1 2 3 4 Posttest scores Pretest-posttest dif. significant Wilcoxon $p < .05$	1 2 1 2 2 1 2 2 2 1 2 0 1 2 3 4 Posttest scores Prestest-posttest dif. signficant Wilcoxon $p < .05$

Table 5

Frequency of Observer Recording Percentages of Student Behavior in Each of Four Categories

Percentage of Time Observed for Category	Category 1 Working with Apparatus		Category 3 Discussing Science		Category 4 Listening		Category 5 Observing	
	Re-source	Main-stream*	Re-source	Main-stream	Re-source	Main-stream	Re-source	Main-stream
0-4	5%	7%	23%	50%	52%	53%	63%	71%
5-9	0	0	16	20	14	15	13	12
10-14	1	0	19	11	9	7	10	5
15-19	3	0	13	7	6	7	3	5
20-24	3	3	10	6	5	3	2	1
25-29	1	2	6	3	4	3	3	2
30-34	5	3	5	4	3	1	4	
35-39	4	4	3	2	1			1
40-44	7	2	1		2	2	1	1
45-49	4	3	1			2		1
50-54	5	4	1	1		2	1	
55-59	4	6		1		1		
60-64	8	5						
65-69	6	5			1			
70-74	7	9		1		1		
75-79	7	7						1
80-84	9	12						
85-89	6	9				1		
90-94	9	5			1		1	
95-99	6	14						

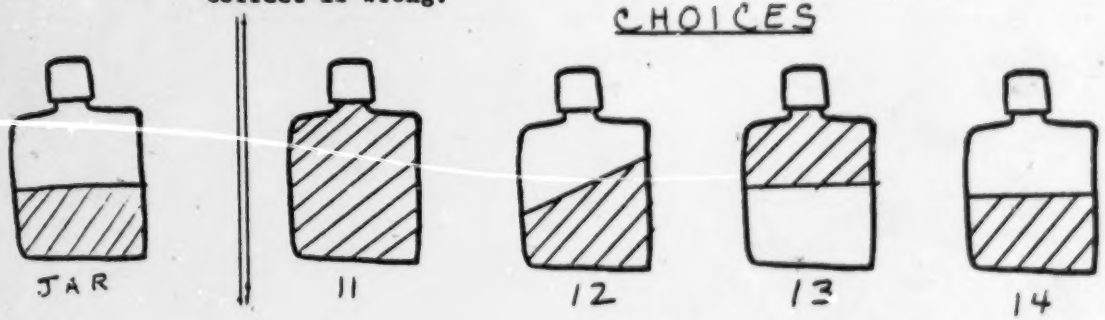
* Resource $\underline{N}$ = 250 observations
Mainstream $\underline{N}$ = 186 observations

Figure 1. Water level task from Cognitive Evaluation

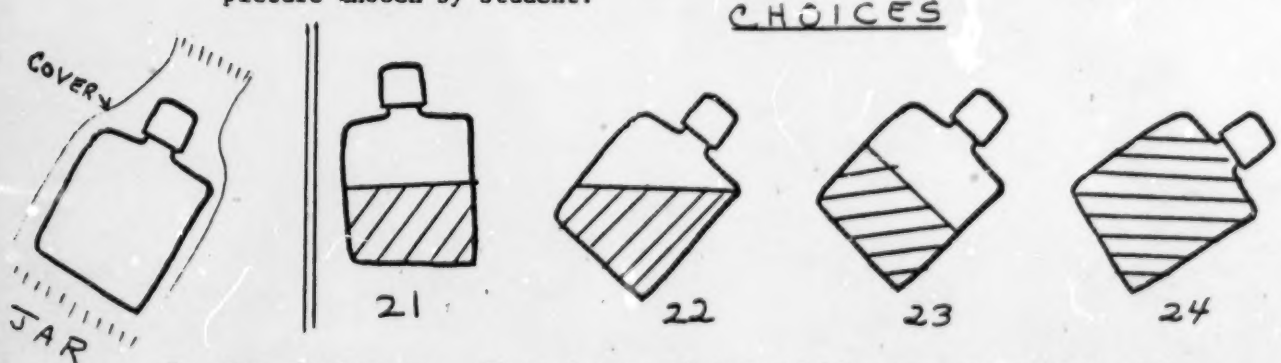
Materials

glass jar filled with blue water
yellow cover for jar
blue marking pen
4 pictures of jar upright
blank pictures of jar to be filled in by student

1. Place uncovered jar with blue water on table. Place 4 pictures of jar upright (11-14) in front of student. Indicate that student should choose picture that shows jar as it is now. Correct ___ Wrong ___ Correct if wrong.



2. Cover jar with yellow cover. Remove pictures from 1. Place pictures (21-24) before student. Turn covered jar to side as shown. Indicate picture chosen by student:



5. Remove pictures. Give picture of jar and blue pen to student. Tip covered jar to opposite side. Indicate that student should draw how water will be. Make sure that student draws which side of his line the water will be on. (It is not necessary to wait until student colors the whole area.) Write student's name on his drawing and attach to other interview materials.